able, and to the fact that the raw materials cost nothing and are always at hand, nitric acid can be produced there by the arc process at less cost than by any other commercial process. Efforts to introduce this process outside Norway have been unsatisfactory, partly because of its uneconomical use of power, and partly because of the difficulty in the subsequent handling of the end-product, a 30–35 per cent. acid against a 50–55 per cent. acid obtained by other processes.

The Haber process for ammonia synthesis was brought to a successful commercial stage in Germany in 1913, when the plant capacity was 30,000 tons of ammonium sulphate. In 1918 the output by this process was 1,060,000 tons of ammonium sulphate. The process consists of forming ammonia by the direct combination, under the influence of a catalyser, of nitrogen from the air and hydrogen obtained from water. The production and purification of the hydrogen involve one of the chief items of cost in this process, but in spite of this the Haber is the cheapest process for the production of synthetic ammonia, and has the lowest power requirement of any of the nitrogen fixation methods.

In 1906 the calcium cyanamide process was successfully installed in Italy, and before the war it was also installed in Germany, Norway, France, Switzerland, the United States, Austria, Japan, and Sweden. The method is a complicated one, and involves a large number of stages, but it has developed extensively, because it requires only about one-fifth the horse-power per ton of fixed nitrogen per year that is required by the arc process, though five times that required by the Haber process.

Several other methods for nitrogen fixation are being experimented with, but they are not yet developed commercially. Mr. Fischer, after a full discussion, concludes that the result is that Germany can produce nitrates at one-half the cost in the United States, and, consequently, the German farmer can be supplied with fertilisers at one-half the cost to the American farmer. This is an enormous advantage to Germany, and if Germany succeeds in monopolising this industry —which she is in a position to do, barring internal disorders—she can either export nitrates at a price which will enable her to supply her farmers with fertilisers at a negligible cost, or undercut the price of nitrogenous products so that it will be unprofitable for the Chilean mines to continue working. Germany would thus in time indirectly control the world's production of explosives. Mr. Fischer therefore urges on the American people the importance of constructing plants for producing synthetic nitrates, by which means "our security would be vastly increased, the burden of obligation carried by our fleet would be greatly reduced, and its functional, effective value doubled."

Industrial Research Associations.

VIII.—The British Photographic Research Association.

By Dr. T. Slater Price.

THE British Photographic Research Association was the first research association to be formed under the scheme of the Privy Council for the promotion of industrial and scientific research. Early in 1918 the manufacturers of photographic materials and apparatus decided to avail themselves of the scheme, and the research association was incorporated on May 15, 1918. The president of the association is Sir J. J. Thomson, and the chairman Mr. Gerald M. Bishop, of Messrs. Marion and Co., Ltd. The council of the association consists of representatives from the various sections of the industry, together with several well-known men of science, who are also represented on the list of vice-presidents. The first director of research was Dr. R. E. Slade, and laboratory accommodation was obtained in the chemical department of University College, Gower Street, where work was carried on until the end of September, 1920. Owing to the large influx of students in the present session, however, it was necessary to vacate the laboratories at University College, and at the beginning of October the research association was transferred to the Institute of Chemistry, 30 Russell Square, W.C.1, where various rooms have been specially fitted and equipped for research work. In March, 1920, Dr. Slade resigned his position as director of research, and the present writer was appointed his successor, taking up his duties in the middle of September last.

As stated in the programme of research which has been issued, the object of the association is to carry out research in photography, photochemistry, and other related subjects with a view to the general increase of knowledge of the subjects, to improve methods of manufacturing photographic materials, and to discover new photographic processes. It is recognised that manufacturers will always insist on determining for themselves the lines on which their businesses shall develop, and the true aim of the association should be, by the proper application of scientific methods, to obtain knowledge which will be of the widest application to the industry, and which it will be left to each manufacturer to apply in his own way to the development of his business.

It is recognised not only that applied research should be undertaken in connection with the improvement of products now being manufactured and of methods of manufacture, but also that pure research on the scientific basis of photography and on related subjects such as colloidal chemistry and photochemistry should be carried out, although

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there may not necessarily be any immediate application of the results to manufacturing processes. Pure research of this nature has already been done, as is instanced by the following list of published papers :—

Contrast and Exposure in X-ray Photographs through Metals, by R. E. Slade (Trans. Faraday Soc., 1919, vol. xv., p. 52). A discussion of the effects of various qualities of X-rays on the photographic plate, and the possibilities of using plates to detect very small flaws in the examination of large bodies of metal.

The Fundamental Law for the True Photographic Rendering of Contrast, by A. W. Porter and R. E. Slade (*Phil. Mag.*, 1919, vol. xxxviii., p. 187). A consideration of the conditions which must be fulfilled by photographic materials in order that a true reproduction of the tone-values of an object may be obtained in the final print.

The Emulsion for a Process Plate, by R. E. Slade and G. I. Higson (*Phot. Journ.*, 1919, vol. lix., p. 260). A description of the type of silver halide emulsion most suitable for a process plate giving great contrast.

Photomicrography in Photographic Research, by G. I. Higson (*Phot. Journ.*, 1920, vol. lx., p. 140). A description of a special type of photomicrographic apparatus specially designed for high-power work in the examination of emulsions.

The Photometric Constant, by G. I. Higson (*Phot. Journ.*, 1920, vol. lx., p. 161). A mathematical discussion of the relation between the photometric density and the quantity of silver deposit in a photographic plate.

A New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide, by R. E. Slade and F. C. Toy (Proc. Roy. Soc., 1920, A, vol. xcvii., p. 181). A description of a new method free from certain sources of error, by means of which the extinction curve for silver bromide was determined throughout the visible and ultra-violet regions of the spectrum.

Some Problems in High-power Photomicrography, by R. E. Slade and G. I. Higson (Trans. Faraday Soc., 1920, vol. xvi., p. 101). A contribution to the general discussion on the microscope held by the Faraday Society.

A Simple Non-intermittent Exposure Machine, by G. I. Higson (*Phot. Journ.*, 1920, vol. lx., p. 235). A description of a novel and simple form of exposure machine with which a plate can be exposed to a light of constant intensity for a series of known times.

Photochemical Investigations of the Photographic Plate, by R. E. Slade and G. I. Higson (Proc. Roy. Soc., 1920, A, vol. xcviii., p. 154). An experimental investigation of the photochemical behaviour of the silver bromide grain, from which an expression connecting intensity, time of exposure, and effect on the grains can be deduced.

The Absorption of Light by the Goldberg Wedge, by F. C. Toy and J. G. Ghosh (*Phil. Mag.*, 1920, vol. xl., p. 775). An investigation of the neutrality of the Goldberg wedge, showing that this neutrality is confined to the visible portion of the spectrum.

Before the war the manufacturers of cameras made use of wood which had been stained black right through. It was obtained from Germany, and was not procurable in England after the outbreak of war. The research association undertook the investigation of such a staining process, with successful results, as may be seen by reference to English Patent No. 17,638/19. It now remains for the manufacturers to develop the process on a commercial scale. At the same time, a quick process for staining wood brown right through was devised.

The methods of making sensitive emulsions for coating on plates and papers have been brought to a high standard of excellence by the various English manufacturers. To a large extent, however, the methods used are the result of experience, of trial and error; different manufacturers obtain similar results by widely different methods. An inexhaustible field of work is open for the definite correlation of the physical and chemical properties of the materials used with the methods employed and the sensitiveness and other characteristics of the emulsion obtained. A commencement is being made on this line of work, the technical heads of the various firms putting their experience and knowledge at the disposal of the research association. Any useful results obtained in the research laboratories will then be tested on a large scale in the works, since it is more than usually difficult in emulsion-making to pass successfully from the laboratory to the works scale.

There is also need for improved methods of laboratory testing of the raw materials of the industry so as to establish greater confidence between buyer and seller, particularly in regard to gelatine, bromides, raw and baryta-coated papers, and packing materials.

The literature of photography is very scattered, and, doubtless owing partly to the subtle nature of many photographic phenomena, important details have often been overlooked, with the consequence that the results of different workers often appear very contradictory. One of the objects of the research association is to collect and summarise this literature so that it may be placed at the disposal of the members of the association. Progress is being made in this direction, but it is necessarily slow.

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Obituary.

SIR LAZARUS FLETCHER, F.R.S.

By the death of Sir Lazarus Fletcher, mineralogy loses one who for a long period was recognised as the leading exponent of that branch of science in this country. Born at Salford on March 3, 1854, Sir Lazarus died suddenly from heart failure at Grange-over-Sands on January 6 in the sixty-seventh year of his age. He was educated at the Manchester Grammar School, and afterwards at Balliol College, Oxford, where he held the Brackenbury science scholarship. He obtained first-class honours in mathematical moderations and in the final schools of mathematics and natural science. From 1875–77 he served as demonstrator in physics under Prof. Clifton at the Clarendon Laboratory, and for the next two years he held the Millard lectureship in physics at Trinity College, Oxford. From 1877–80

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